Biological control of the ambermarked birch leafminer, *Profenusa thomsoni* (Hymenoptera: Tenthredinidae), in Alberta

S.C. Digweed, R.L. McQueen, J.R. Spence, and D.W. Langor

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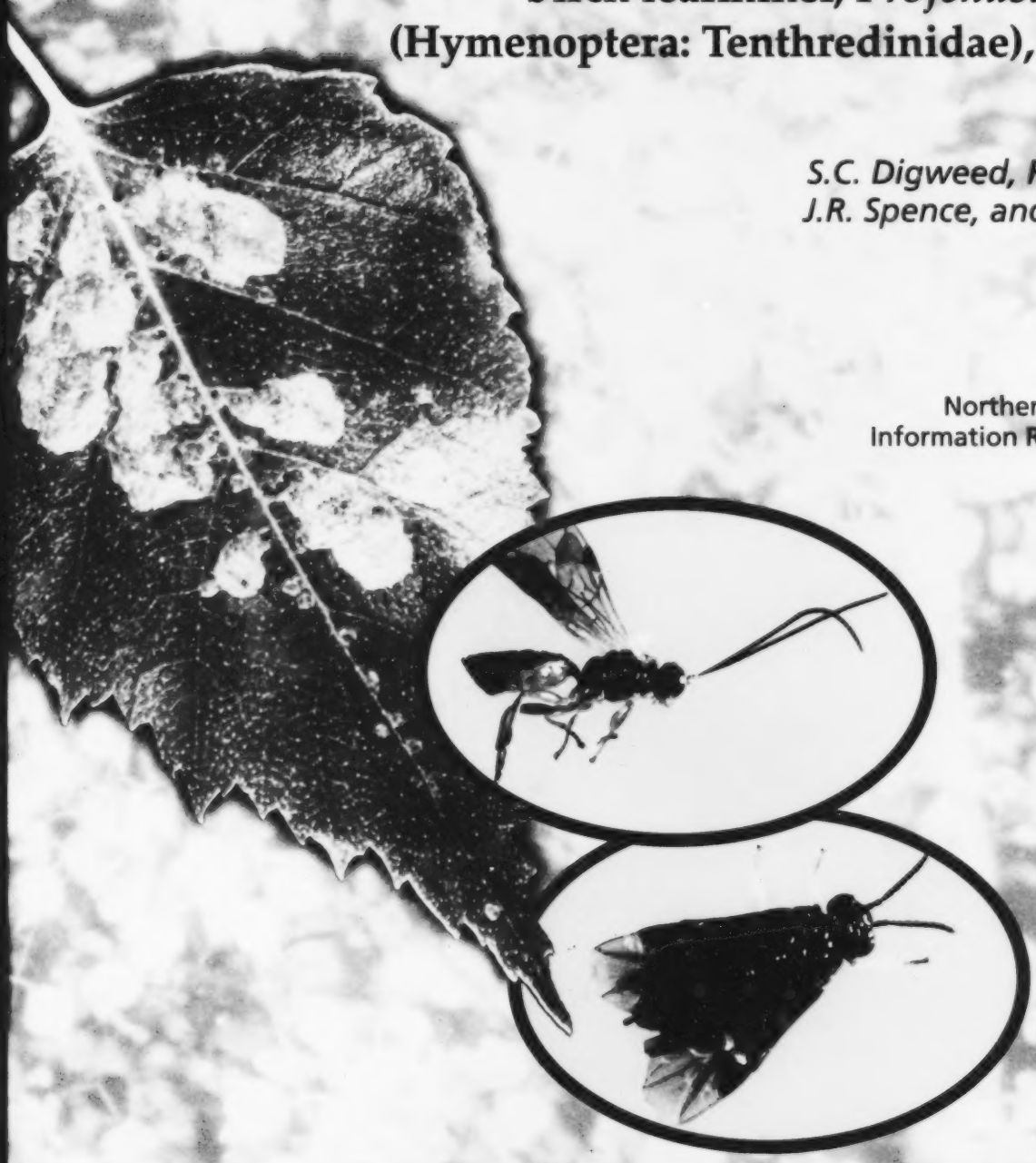

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Cover:

The top insect photo is an adult female *Lathrolestes luteolator* (Gravenhorst), and the bottom insect photo is an adult female *Profenusa thomsoni* (Konow). The birch leaf bears eggs and young instar larvae of *P. thomsoni*. (Insect photos courtesy Chris Saunders, Edmonton Community Services, Parkland Services).

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BIOLOGICAL CONTROL OF THE AMBERMARKED BIRCH LEAFMINER, *PROFENUSA THOMSONI* (HYMENOPTERA: TENTHREDINIDAE), IN ALBERTA

S.C. Digweed[1], R.L. McQueen[1], J.R. Spence[1], and D.W. Langor

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ABSTRACT

The Holarctic ichneumonid parasitoid *Lathrolestes luteolator* (Gravenhorst) was found attacking *Profenusa thomsoni* (Konow), an introduced birch-leafmining sawfly, in Edmonton, Alberta. This appears to be a recently evolved host-parasitoid association in Alberta. Populations of *L. luteolator* increased dramatically relative to those of *P. thomsoni* as the sawfly declined from epidemic to low levels between 1992 and 1995, after a sustained outbreak beginning with its earliest local detection in the early 1970s. The only previously recorded host of *L. luteolator* that occurs in Alberta is the tenthredinid *Caliroa cerasi* L.; however, *L. luteolator* was not associated with a population of *C. cerasi* sampled during 1995. Sampling at several locations in Alberta, Saskatchewan, and Ontario showed that *L. luteolator* is currently associated with populations of *P. thomsoni* throughout Canada. Further study is required to determine whether *L. luteolator* is involved in regulating populations of *P. thomsoni* at the present low levels observed in central Alberta.

RÉSUMÉ

On a observé que le parasitoïde ichneumonide holarctique *Lathrolestes luteolator* (Gravenhorst) attaque le *Profenusa thomsoni* (Konow), une tenthrède-mineuse du bouleau introduite, à Edmonton (Alberta). Il s'agirait d'une association hôte-parasitoïde récente en Alberta. Les populations de *L. luteolator* ont augmenté très fortement alors que les populations de *P. thomsoni* sont passées d'épidémiques à faibles de 1992 à 1995, après une épidémie soutenue apparue avec la première détection locale de cette tenthrède au début des années 1970. Le seul hôte du *L. luteolator* antérieurement signalé en Alberta est le tenthrédinide *Caliroa cerasi* L.; toutefois, le *L. luteolator* n'était pas présent dans une population de *C. cerasi* échantillonnée en 1995. Les échantillonnages réalisés à plusieurs endroits en Alberta, en Saskatchewan et en Ontario indiquent que le *L. luteolator* est actuellement associé à des populations de *P. thomsoni* dans une grande portion du Canada. On devra effectuer d'autres études pour établir si le *L. luteolator* contribue au maintien des populations de *P. thomsoni* aux bas niveaux actuellement observés dans le centre de l'Alberta.

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INTRODUCTION

Five species of birch-leafmining sawflies were inadvertently introduced to North America from Europe in the last century, of which the birch leafminer, *Fenusa pusilla* (Lepeletier), and the ambermarked birch leafminer, *Profenusa thomsoni* (Konow), have become serious, widespread pests of native and introduced birches (*Betula* spp.) (Martin 1960; Cheng and LeRoux 1965; Drouin and Wong 1984; Pezzolesi and Hager 1994; Digweed et al. 1997). Populations of these species were in perpetual outbreak in Edmonton, Alberta, throughout the 1970s and 1980s (Drouin and Wong 1984; Digweed et al. 1997); however, the Edmonton population of *P. thomsoni* crashed in the early 1990s and has remained at low levels ever since.

Profenusa thomsoni, which is rare in Europe, is an atypical member of the tribe Fenusini because it is apparently not attacked by parasitoids of the genera *Lathrolestes* and *Grypocentrus* (Hymenoptera: Ichneumonidae) in its native range, as are most other fenusines (Eichhorn and Pschorn-Walcher 1973; Pschorn-Walcher and Altenhofer 1989; Schönrogge and Altenhofer 1992; Kenis et al. 1995; Kenis and Carl 1996; Fischer 1997). However, in 1994, the Holarctic *Lathrolestes luteolator* (Gravenhorst) was discovered attacking larval *P. thomsoni* in Alberta, a first record of this host–parasitoid association (Barron 1994; Digweed 1998). This parasitoid is a koinobiont, attacking half- to full-grown host larvae and completing most of its larval development within the host's prepupa as it sits in a soil cocoon (Pschorn-Walcher and Altenhofer 1989). In North America, *L. luteolator* also attacks *Profenusa alumna* (MacGillivray), which mines leaves of red oak (*Quercus rubra* L.), and members of the sawfly genus *Caliroa* that feed on oak (*Quercus* spp.) or gum (*Nyssa* spp.) (Barron 1994). In Europe, *L. luteolator* has been recorded from *Caliroa cerasi* L. on a variety of host plants, *Caliroa varipes* Klug on oak, and *Caliroa annulipes* Klug on lime (*Tilia* spp.) (Carl 1976). Of these other hosts of *L. luteolator*, only *C. cerasi* is recorded from Alberta, where the larvae feed externally on leaves of *Cotoneaster* spp., mountain-ash (*Sorbus* spp.), and hawthorn (*Crataegus* spp.) (Ives and Wong 1988; Hiratsuka et al. 1995).

After detection and identification of *L. luteolator* in samples reared from prepupae of *P. thomsoni* during 1994 (Digweed 1998), changes in the relative abundances of adult *L. luteolator* and *P. thomsoni* were assessed for the period 1992–1995. In addition, a local population of *C. cerasi* was investigated to determine whether it was also associated with *L. luteolator* in Alberta. Lastly, an attempt was made to establish the current distribution of the association between *L. luteolator* and *P. thomsoni* by sampling across Alberta, Saskatchewan, and northern Ontario.

MATERIALS AND METHODS

Samples collected for other purposes (*see* Digweed et al. 1997) were re-examined to determine relative abundances of *P. thomsoni* and *L. luteolator*. These samples were obtained from emergence traps set in 1992, sticky traps set in 1994, and emergence and sticky traps newly set for this study in 1995.

Emergence traps were pyramidal (modified from Martin [1977]), with a basal area of 0.22 m^2, two wooden sides, and two fine mesh sides for ventilation. Two traps were placed beneath each of six birch trees in urban habitats in Edmonton during 1992 to capture adult sawflies and parasitoids emerging from the soil after overwintering there. Traps were checked three times per week from early May until early September. During 1994, one sticky trap (yellow 10.0 × 15.0 cm card traps, Phero-Tech, Inc., Vancouver, British Columbia) was placed approximately 2 m above the ground in the outer canopy of five birch trees on the University of Alberta campus, Edmonton. Traps were changed once per week. During 1995, relative capture efficiency of emergence and sticky traps was estimated by setting both types of traps simultaneously on eight birch trees near the University of Alberta campus.

One of the few prolific populations of *C. cerasi* known in Edmonton during 1995 was sampled to determine whether this sawfly is also a host of *L. luteolator* in Edmonton. One emergence trap was set under each of four infested hawthorn trees along the northern boundary of the Edmonton Municipal

Airport; these trees were roughly 300 m from the nearest birch trees. Traps were checked twice per week from early June to early August for adults of *C. cerasi* and *L. luteolator*. Voucher specimens of *P. thomsoni*, *C. cerasi*, and *L. luteolator* were deposited at the E.H. Strickland Entomological Museum, University of Alberta, Edmonton, Alberta.

To assess the geographic extent of the association between *P. thomsoni* and *L. luteolator* in Canada, volunteers in northern Ontario (1994), Alberta (1995), and Saskatchewan (1995) placed sticky traps on mature birches to sample *P. thomsoni* and *L. luteolator* populations (Fig. 1). One sticky trap was placed on each tree, and each trap was changed every 1 to 2 weeks from early May until late September (Ontario) or from 30 June to 28 July (Alberta and Saskatchewan). One tree was sampled at each of the following localities: Fort McMurray, Slave Lake, and Lethbridge, Alberta; Saskatoon, Saskatchewan; and Sudbury, Kapuskasing, Sioux Lookout, Geraldton, and Temagemi, Ontario. Two trees were sampled at each of Sir Winston Churchill Provincial Park, Alberta; Touchwood Lake, Alberta; and Thunder Bay, Ontario. Three trees were sampled in Calgary, Alberta, and eight trees were sampled in Edmonton (by the authors, as outlined above). The number and location of trees sampled was determined by availability of volunteers. All traps were returned to Edmonton, and adults of *P. thomsoni* and *L. luteolator* were counted.

RESULTS

In Edmonton, flight activity of *P. thomsoni* occurred in the last week of June and the first 3 weeks of July, and peak activity of *L. luteolator* occurred in mid-July (Fig. 2). Comparison of emergence trap catches in Edmonton in 1992 and 1995 showed a decrease in *P. thomsoni* captures (mean number of individuals per tree ± standard error, 47.7 ± 19.8 [$N = 6$] in 1992 and 0.8 ± 0.8 [$N = 8$] in 1995) relative to those of *L. luteolator* (6.3 ± 4.0 [$N = 6$] in 1992 and 1.3 ± 0.6 [$N = 8$] in 1995). These abundances translate to mean host:parasitoid ratios of 7.6:1 in 1992 and 0.6:1 in 1995. Sticky trap samples from 1994 and 1995 indicated low abundances of *P. thomsoni* (139.8 ± 66.0 [$N = 5$] in 1994 and 29.1 ± 4.6 [$N = 8$] in 1995) relative to those of *L. luteolator* (598.8 ± 152.8 [$N = 5$] in 1994 and 62.4 ± 24.5 [$N = 8$] in 1995). These abundances translate to low host:parasitoid ratios in both 1994 (0.2:1) and 1995 (0.5:1).

Males constituted 89.7% ± 2.0% (1994, $N = 5$ trees) and 67.2% ± 4.9% (1995, $N = 8$) of the *L. luteolator* catch from sticky traps, but only 33.1% ± 7.9% (1992, $N = 5$) and 56.7% ± 20.8% (1995, $N = 4$) of the catch from emergence traps. However, the difference in the proportion of males caught by the two types of traps during 1995 was not statistically significant (Mann-Whitney U test, $\alpha = 0.05$, $n_1 = 4$, $n_2 = 8$, $p > 0.20$). Of 15 *L. luteolator* reared from *P. thomsoni* in the laboratory during 1995, 7 (47%) were males.

In total, 88 adult *C. cerasi* were captured during July 1995, with peak activity from 11 to 18 July (47.1% ± 14.5% [$N = 4$ trees] of the catch occurred on three trapping dates during this period), which is similar to the peak activity period of adult *P. thomsoni* (Digweed et al. 1997). However, no *L. luteolator* were associated with this *C. cerasi* population.

Surveys conducted by volunteers during 1994 and 1995 showed that *L. luteolator* co-occurs with *P. thomsoni* in both Alberta and Ontario. Adults of both species were collected together in Edmonton, Calgary, Fort McMurray, and Sir Winston Churchill Provincial Park in Alberta, and Sudbury and Temagemi in Ontario (Fig. 1). Although *P. thomsoni* also occurred at all other locations sampled in western Canada (Touchwood Lake, Slave Lake, Lethbridge, and Saskatoon), no *L. luteolator* were captured at these sites.

DISCUSSION

Although there is a strongly suggestive correlation between the recent increase in abundance of *L. luteolator* and the collapse of *P. thomsoni* in Edmonton (*see also* Digweed 1998), there is still

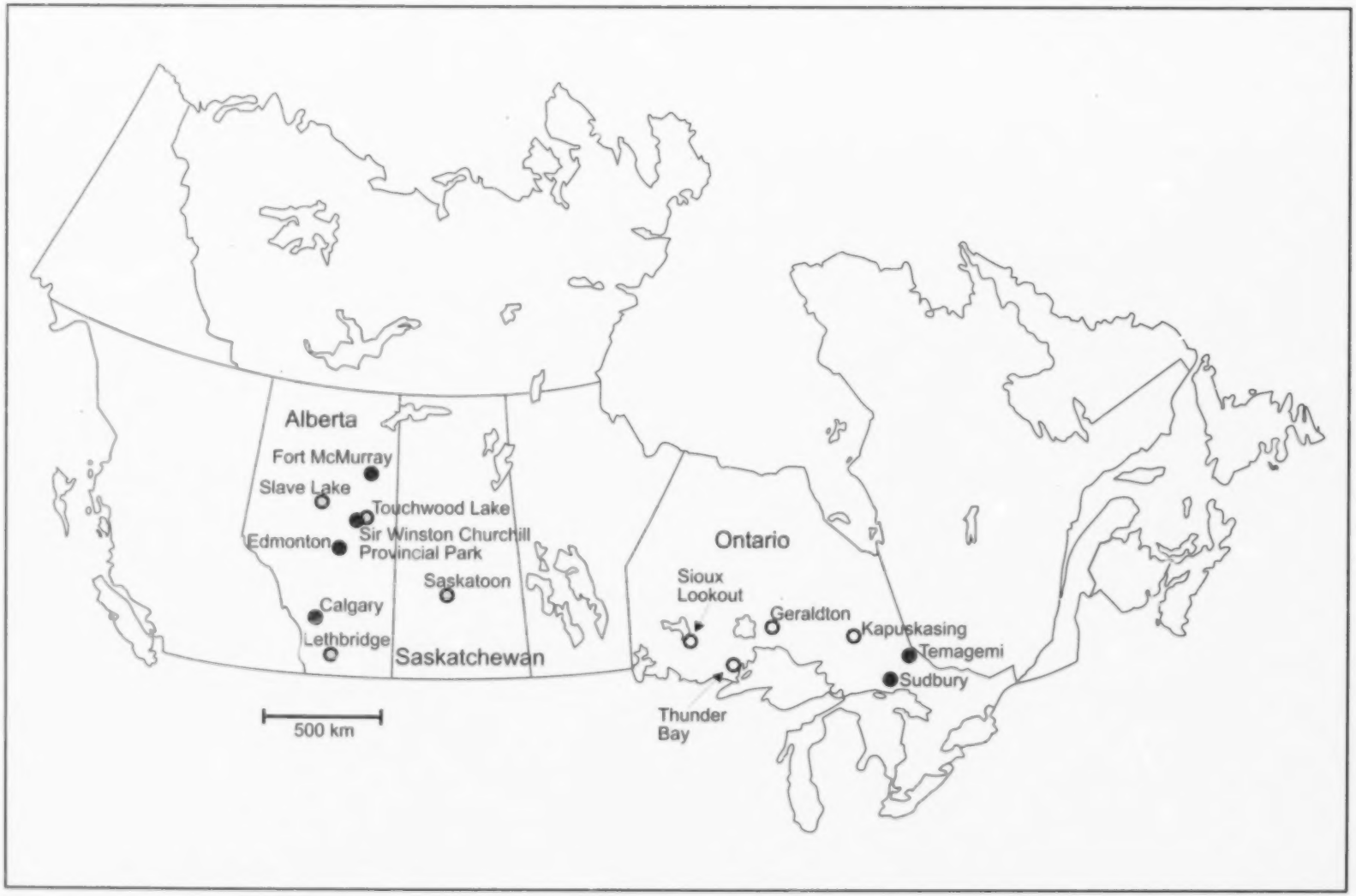

Figure 1. Locations sampled for *Profenusa thomsoni* and *Lathrolestes luteolator* in Alberta and Saskatchewan (1995) and Ontario (1994). Solid circles = both *P. thomsoni* and *L. luteolator* collected; shaded circles = only *P. thomsoni* collected; open circles = neither species collected.

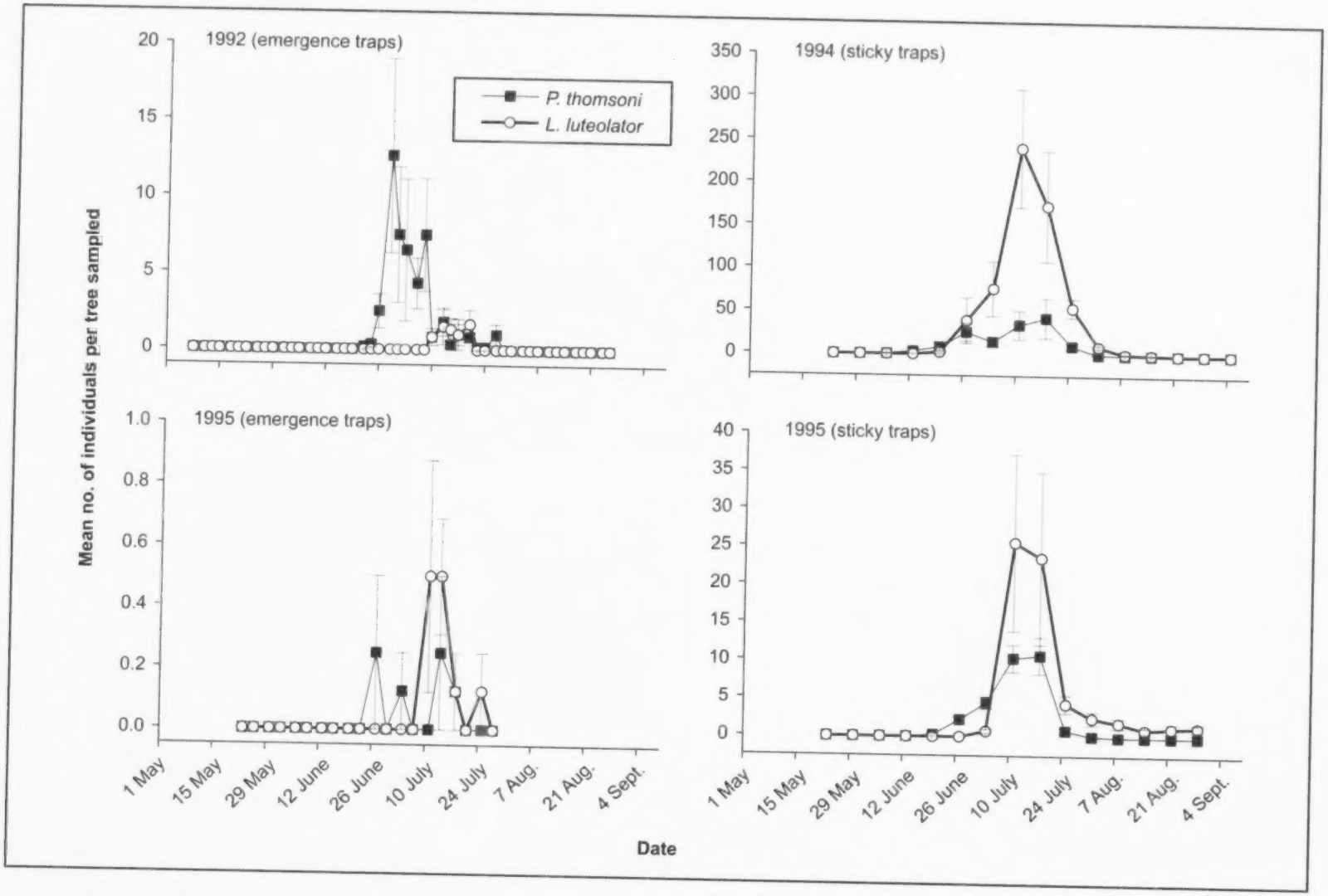

Figure 2. Flight activity of *Profenusa thomsoni* and *Lathrolestes luteolator* in Edmonton, Alberta, as indicated by captures in emergence traps and sticky traps in 1992, 1994, and 1995.

insufficient evidence to establish unequivocally that the parasitoid is a causal agent in the collapse or regulation of *P. thomsoni* populations. An extension of the detailed life-table studies of Digweed (1998) to examine mortality of prepupae should reveal any regulatory effects of *L. luteolator*. Because populations of *P. thomsoni* have been very low in Edmonton since their collapse in 1993 and 1994, further studies should be conducted in regions where *P. thomsoni* abundances are higher. Such sites exist elsewhere in northern Alberta and the Northwest Territories, where *P. thomsoni* populations appear to have remained large when *L. luteolator* is absent or rare (C. Saunders, Edmonton Community Services, Parkland Services, personal communication, letter, February 2003).

Whatever the cause, the decrease in *P. thomsoni* populations is believed to be largely responsible for a 60–70% decrease in the use of the pesticide dimethoate in the Edmonton area over the period 1993–1998 (Alberta environment data, C. Saunders, Edmonton Community Services, Parkland Services, personal communication, e-mail, 12 April 2000). In fact, the City of Edmonton suspended pesticide treatment of birches on city land in 1996, and there has been no resurgence of the pest to date (Edmonton Community Services. 2000 [updated 2001]. Urban forest insect pest and disease report. Edmonton, AB. <http://www.gov.edmonton.ab.ca/comm_services/parkland_services/pest_management/urban_forest_pests_1.html>. Accessed 2 September 2003.).

The relatively broad host range of *L. luteolator* makes it an exceptional member of the genus *Lathrolestes*, because most species attack only one or two species of leafmining sawfly (Pschorn-Walcher and Altenhofer 1989; Barron 1994). Barron (1994) suggested that *L. luteolator* usually occurs on oak-feeding *Caliroa* spp. and *P. alumna* and switches to the birch-feeding *P. thomsoni* in western Canada because oaks and their sawflies are rare there. However, in this study *L. luteolator* was associated with *P. thomsoni* on birch at locations in Ontario where oak and birch and their associated sawflies (subfamily Heterarthrinae) co-occur, which suggests that *P. thomsoni*, *P. alumna*, and oak-feeding *Caliroa* spp. are sympatric alternate hosts of *L. luteolator* there. It was not possible to confirm an association between *L. luteolator* and *C. cerasi* on hawthorn in Edmonton.

It is difficult to assess the novelty of the association reported here and by Digweed (1998), because few studies have examined *P. thomsoni* parasitoids in Europe. Although *L. luteolator* is associated with *P. thomsoni* across Canada, this association has not been recorded in Europe (Pschorn-Walcher and Altenhofer 1989; Schönrogge and Altenhofer 1992; Kenis et al. 1995; Kenis and Carl 1996; Fischer 1997). However, this may simply reflect the fact that only very small samples of *P. thomsoni* have been examined for parasitoids in Europe (Kenis et al. 1995). Further study in Europe is necessary to demonstrate convincingly that this host–parasitoid association is not Holarctic.

There are two possible sources for the host association reported here: either it is ancient, and *L. luteolator* attacking *P. thomsoni* in Europe was introduced with *P. thomsoni*, or it is recent, with Nearctic *L. luteolator* switching to attack *P. thomsoni* since its introduction. If the association is recent, either it originated once and subsequently spread as *P. thomsoni* has spread, or it arose repeatedly, with local populations of *L. luteolator* switching from *P. alumna* or *Caliroa* spp. to attack *P. thomsoni* as the new host spread. The association between *L. luteolator* and *P. thomsoni* was detected in both eastern and western Canada, and it is possible that the association existed in northern Ontario as early as the 1950s (if *Lathrolestes* sp. reared by Martin [1960] from *P. thomsoni* was actually *L. luteolator*). However, Drouin and Wong (1984) did not report the relationship in Alberta during the 1970s. Thus, the association may have arisen locally in Alberta, expanding dramatically in the early 1990s after remaining at very low levels for up to 20 years, or it may have spread to Alberta from eastern Canada sometime between Drouin and Wong's study and the current one.

In conclusion, we hypothesize that *L. luteolator* has expanded its host range to include *P. thomsoni*. Additional work showing that *P. thomsoni* populations in Europe are not attacked by *L. luteolator* would provide more convincing evidence that this host–parasitoid association is not ancient. Future studies in North America should be able to demonstrate any regulatory effects of *L. luteolator* on *P. thomsoni* populations and may be able to test hypotheses about the origin of the association by focusing on regions where *P. thomsoni* and the *P. thomsoni*–*L. luteolator* association appear to be new (e.g., northern Alberta or the Northwest Territories). Such studies could examine geographic variation in *L. luteolator* host ranges and genetic variation among *L. luteolator* populations from different regions or reared from different host species.

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